

VIDEO DISTRIBUTION AMPLIFIER FOR UPSTREAM DATA SYSTEMS

BACKGROUND OF THE INVENTION

1. Field of the Invention.

[0001] The present invention relates to video distribution amplifiers, and, more particularly, to video distribution amplifiers for transmitting active video signals and data signals on cables.

2. Description of the Related Art.

[0002] Video systems commonly include an input video source, such as a camera, that transmits active video signals and data signals in a downstream direction to multiple output receivers, such as video monitors. Each receiver may receive both the active video signals and the data signals on a single, respective port. The video systems also often include active devices, such as amplifiers, between the video source and the receivers. The amplifiers may operate to amplify, i.e., increase the magnitude of, the active video signals and data signals so that the signals can be more readily used by the receivers. A video distribution amplifier may amplify signals from an input and distribute the amplified signals to a plurality of outputs. A video distribution amplifier may include a plurality of individual amplifiers, with each individual amplifier transmitting signals to a single respective one of the outputs.

[0003] It would be desirable to transmit data signals from the receivers to the video source in an upstream direction on the same ports on which the downstream signals are transmitted. Moreover, it would be desirable to transmit data signals from one of the receivers to the other receivers in an upstream direction on the same ports on which the downstream signals are transmitted. A problem is that active devices, such as amplifiers, typically allow signals to pass through them in only one direction. That is, an amplifier that amplifies signals in a downstream direction also blocks signals that are being transmitted in an upstream direction, such as from an output to an input. Thus, an amplifier does not allow data signals to be transmitted in an

upstream direction from an output to an input, or from an output to another output, on a same port on which downstream signals are carried from an input to multiple outputs.

[0004] What is needed in the art is a video system that includes active devices that transmit signals in a downstream direction from an input to a plurality of outputs, and that yet allows signals to be transmitted in an upstream direction from the outputs to the input, or from an output to other outputs, wherein the signal transmission may be bi-directional on an individual port. What is further needed is a video distribution amplifier that transmits signals in a downstream direction from an input to a plurality of outputs, and that yet allows signals to be transmitted in an upstream direction from the outputs to the input, or from an output to other outputs.

SUMMARY OF THE INVENTION

[0005] The present invention provides a video distribution amplifier in which upstream-directed signals from output devices may bypass individual amplifiers within the video distribution amplifier and reach an input device and other output devices.

[0006] The invention comprises, in one form thereof, a video system including a video source operable to transmit an active video signal on a transmission line. Each of a plurality of video receivers transmits a respective data signal on a respective one of a plurality of ports. A distribution device is electrically connected to the transmission line and to each of the ports. The distribution device transmits each of the data signals to the video source on the transmission line. The distribution device includes a plurality of amplifiers. Each amplifier has an input and an output, and receives signals on the input for transmission on the output as amplified signals. Each amplifier is operable to block signals received on the output from being transmitted on the input. Each amplifier transmits a respective amplified signal to a respective one of the receivers on a respective one of the ports. Each amplified signal is dependent upon the active video signal and upon a data signal from the receivers other than the respective receiver.

[0007] The invention comprises, in another form thereof, a video system including a video source transmitting an active video signal on a transmission line. Each of a plurality of video receivers transmits a respective data signal on a respective port. A distribution device is in electrical communication with the transmission line and with each of the ports. The distribution

device is operable to transmit each of the data signals to the video source. The distribution device includes a plurality of active devices. Each active device transmits a respective active-device-signal to a respective one of the receivers on a respective one of the ports. Each active-device-signal is dependent upon the active video signal and at least one of the data signals from the receivers other than the respective receiver.

[0008] The invention comprises, in yet another form thereof, a video distribution apparatus including a first port configured to be electrically connected to a video source. Each of a plurality of second ports is electrically connected to a respective video receiver. Each of a plurality of active devices has an input and an output. Each output is electrically connected to a corresponding one of the second ports. Each input receives active video signals from the video source via the first port. Bypass circuitry transmits data signals from each of the second ports to the first port and to the inputs of the active devices such that the data signals bypass the active devices.

[0009] An advantage of the present invention is that video transmission cables and ports can carry signals bi-directionally between a video source and multiple receivers. Thus, a single cable or port can be used where two cables or ports might otherwise be needed to carry signals in different respective directions.

[0010] Another advantage is that an output device may bypass a downstream directed active device, such as an amplifier, to thereby send signals upstream to an input device and to other output devices. Downstream and upstream signals can both be carried on a single cable or port.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The above mentioned and other features and objects of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

Figure 1 is a block diagram of one embodiment of a video system of the present invention.

Figure 2A is a schematic diagram of a first section of one embodiment of the video distribution amplifier of the system of Figure 1.

Figure 2B is a schematic diagram of a second section of the video distribution amplifier of Figure 2A.

Figure 2C is a schematic diagram of a third section of the video distribution amplifier of Figure 2A.

Figure 3 is a block diagram of another embodiment of a video system of the present invention, accommodating any number of video receivers.

[0012] Corresponding reference characters indicate corresponding parts throughout the several views. Although the exemplification set out herein illustrates embodiments of the invention, in several forms, the embodiments disclosed below are not intended to be exhaustive or to be construed as limiting the scope of the invention to the precise forms disclosed.

DESCRIPTION OF THE PRESENT INVENTION

[0013] Referring now to the drawings and particularly to Figure 1, there is shown one embodiment of a video system 10 of the present invention, including a video source 12, a video distribution apparatus 14, upstream coaxial type transceivers 16a, 16b and video receivers 18a, 18b. Video source 12 may be in the form of a video camera with a transceiver for transmitting and receiving signals. That is, video source 12 may transmit a video output signal including active video signals and downstream data signals as well as receive upstream data signals via an associated transceiver. More particularly, the transceiver of video source 12 can transmit active video signals and downstream data signals on a first transmission line, which may be in the form of a first unshielded twisted pair (UTP) or first coaxial cable 20. Commonly used UTP type cables that may be used with the present invention include Cat-5, Cat-5e and Cat-6 cable. The upstream and downstream data signals may include control data, configuration data, and other digital data. The active video signal and upstream and downstream data signals may be formatted in fields that enable the actual video signals to be displayed as a series of horizontal video lines on the screen of a video receiver. The upstream and downstream data signals may be

carried in the vertical blanking interval (VBI) of each field such that the data signals do not affect what is displayed on the screen.

[0014] The active video signals and downstream data signals are generally passed to video receivers 18a, 18b via first cable 20, distribution apparatus 14, transceivers 16a, 16b, second transmission lines in the form of communications channels 17a, 17b, which may be compatible with RS-232, RS-485, or Ethernet, for example, and third transmission lines in the form of second UTPs or second coaxial cables 22a, 22b. The downstream data signals can be carried on channels 17a, 17b, and the active video signals can be carried on cables 22a, 22b.

[0015] Video receivers 18a, 18b can transmit upstream data signals on channels 17a, 17b. The upstream data signals are generally passed to video source 12 and to the video receiver other than the video receiver that originates the upstream data signal. For example, upstream data signals from video receiver 18a are passed to video source 12 and to video receiver 18b. Similarly, upstream data signals from video receiver 18b are passed to video source 12 and to video receiver 18a. The upstream data signals are generally passed to video source 12 via channels 17a, 17b, transceivers 16a, 16b, distribution apparatus 14, and first cable 20.

[0016] Video distribution apparatus 14 can be in the form of a device commonly referred to as a video distribution amplifier (VDA), as in the embodiment of Figure 1. Despite itself being referred to as an "amplifier", a video distribution amplifier may include multiple active devices in the form of individual amplifiers or buffers. VDA 14 includes such individual driving amplifiers 24a and 24b for amplifying and transmitting active video signals, downstream data signals and selected upstream data signals to video receivers 18a, 18b, respectively. More particularly, amplifier 24a amplifies and transmits active video signals, downstream data signals and upstream data signals from video receiver 18b to video receiver 18a. Similarly, amplifier 24b amplifies and transmits active video signals, downstream data signals and upstream data signals from video receiver 18a to video receiver 18b. In one embodiment, amplifiers 24a, 24b each have a gain of two.

[0017] Amplifiers 24a, 24b include respective inputs 26a, 26b and respective outputs 28a, 28b. Amplifiers 24a, 24b are generally one-way active devices in that they pass active-device-

signals in only one direction. For instance, amplifier 24a receives signals on input 26a and transmits or otherwise passes the signals from input 26a as amplified signals on output 28a. Amplifier 24a also blocks signals received on output 28a from being transmitted on input 26a. That is, amplifier 24a prevents signals from passing through amplifier 24a in a reverse direction from output 28a to input 26a. Thus, amplifier 24a transmits signals only on its output 28a. Similarly, amplifier 24b receives signals on input 26b and transmits or otherwise passes the signals from input 26b as amplified signals on output 28b. Amplifier 24b also blocks signals received on output 28b from being transmitted on input 26b. That is, amplifier 24b prevents signals from passing through amplifier 24b in a reverse direction from output 28b to input 26b. Thus, amplifier 24b transmits signals only on its output 28b.

[0018] VDA 14 includes a first port 30 that is electrically connected to video source 12 and its associated transceiver through coaxial cable 20. VDA 14 also includes second ports 32a, 32b that are electrically connected to respective video receivers 18a, 18b through respective transceivers 16a, 16b and respective coaxial cables 22a, 22b.

[0019] VDA 14 includes bypass circuitry 34 for bypassing one-way amplifiers 24a, 24b to thereby allow data signals from video receivers 18a, 18b to be transmitted in an upstream direction to video source 12 and to the other one of video receivers 18a, 18b. Bypass circuitry 34 transmits upstream data signals from second ports 32a, 32b to first port 30 and to inputs 26a, 26b of amplifiers 24a, 24b such that the upstream data signals bypass, i.e., circumvent, one-way amplifiers 24a, 24b. More particularly, bypass circuitry 34 transmits upstream data signals from each of second ports 32a, 32b to first port 30 and to the input of the amplifier not corresponding to the second port from which the upstream data signal originates. For example, bypass circuitry 34 transmits upstream data signals from second port 32a to first port 30 and to input 26b of amplifier 24b. In the embodiment of Figure 1, bypass circuitry 34 does not transmit upstream data signals from second port 32a to input 26a of amplifier 24a, which amplifier corresponds to the second port 32a from which the upstream data signals originate. Similarly, bypass circuitry 34 transmits upstream data signals from second port 32b to first port 30 and to input 26a of amplifier 24a, but not to input 26b of amplifier 24b.

[0020] Bypass circuitry 34 includes receiver-specific sections 36a, 36b and a common section 38. Receiver-specific sections 36a, 36b have respective first inputs 40a, 40b each electrically connected to an output 42 of common section 38. Receiver-specific sections 36a, 36b also have respective second inputs 44a, 44b each electrically connected to respective first outputs 46b, 46a of the other one of the receiver-specific sections 36a, 36b. First outputs 46a, 46b are also electrically connected to respective inputs 48a, 48b of common section 38. Second outputs 50a, 50b of receiver-specific sections 36a, 36b are electrically connected to respective amplifier inputs 26a, 26b. Third inputs 52a, 52b of receiver-specific sections 36a, 36b are electrically connected to respective amplifier outputs 28a, 28b and to respective second ports 32a, 32b. Finally, common section 38 has an input/output 54 electrically connected to first port 30.

[0021] Receiver-specific sections 36a, 36b include respective adders 56a, 56b, bypass amplifiers 58a, 58b, and subtractors 60a, 60b. Amplifiers 58a, 58b provide a signal propagation delay substantially equal to that of amplifiers 24a, 24b, respectively, to facilitate the operation of subtractors 60a, 60b, respectively. Bypass amplifiers 58a, 58b may be active one-way devices that function substantially the same as amplifiers 24a, 24b, as described above. Thus, the characteristics of bypass amplifiers 58a, 58b will not be discussed in further detail herein. Common section 38 includes an input adder 62, an output adder 64, and a subtractor 66.

[0022] Transceivers 16a, 16b receive the video output signals and upstream data signals from the other transceiver via respective ports 32a, 32b, and extract the active video signals, downstream data signals, and/or received upstream data signals therefrom. Transceivers 16a, 16b can transmit the active video signals to video receivers 18a, 18b on respective transmission lines 22a, 22b, and can transmit the downstream data signals to video receivers 18a, 18b on respective communications channels 17a, 17b. Video receivers 18a, 18b can transmit upstream data signals to respective transceivers 16a, 16b on respective communications channels 17a, 17b. Transceivers 16a, 16b also can insert the upstream data signals received from respective video receivers 18a, 18b on respective ports 32a, 32b.

[0023] Video receivers 18a, 18b may include respective control systems 68a, 68b, and respective video sinks in the form of monitors 70a, 70b. Control systems 68a, 68b may each

include a video switcher, a multiplexer and/or a driver (not shown). Control systems 68a, 68b may each process the active video signals that control systems 68a, 68b receive on second coaxial cables 22a, 22b as well as the downstream data signals that control systems 68a, 68b receive on channels 17a, 17b. Control systems 68a, 68b may then transmit the processed active video signals to respective monitors 70a, 70b for visual display on the screens of the monitors. Control systems 68a, 68b may also create upstream data signals based, at least in part, upon the active video signals, downstream data signals, and upstream data signals from other receivers that the control systems receive. Further, control systems 68a, 68b may transmit the upstream data signals on respective channels 17a, 17b.

[0024] In operation, video source 12 transmits active video signals and downstream data signals to VDA 14, which inputs the signals into each of adders 56a, 56b. Video receivers 18a, 18b transmit respective upstream data signals to VDA 14, which inputs each of the upstream signals into the one of the adders 56a, 56b that does not correspond to the video receiver from which the upstream signals originate. For example, VDA 14 inputs upstream signals from video receiver 18a into adder 56b, and inputs upstream signals from video receiver 18b into adder 56a. The outputs of adders 56a, 56b are fed into respective inputs 26a, 26b of amplifiers 24a, 24b. Amplifiers 24a, 24b amplify the active video signals, downstream data signals and upstream data signals for transmission to corresponding video receivers 18a, 18b. That is, amplifiers 24a, 24b transmit, on outputs 28a, 28b, signals that are dependent upon the signals received on inputs 26a, 26b. These amplified output signals are transmitted on coaxial cables 22a, 22b and channels 17a, 17b to respective video receivers 18a, 18b.

[0025] The transmission of active video signals, downstream data signals, and non-corresponding upstream data signals by amplifier 24a, and transmission of corresponding upstream data signals by video receiver 18a, results in both sets of signals being carried by port 32a and being present at third input 52a. Thus, a single port 32a is used to transmit both downstream-directed signals and upstream-directed signals. Similarly, the transmission of active video signals, downstream data signals, and non-corresponding upstream data signals by amplifier 24b and transmission of corresponding upstream data signals by video receiver 18b results in both sets of signals being carried by port 32b and being present at third input 52b.

[0026] Subtractors 60a, 60b subtract out the active video signals, downstream data signals, and non-corresponding upstream data signals from the signals received at third inputs 52a, 52b, thereby leaving only, i.e., extracting, the corresponding upstream data signals to be transmitted on first outputs 46a, 46b. In addition to being received at the non-corresponding one of adders 56a, 56b, as mentioned above, the upstream data signals are collected and summed at adder 62. The output of adder 62 is transmitted both to adder 64 and to subtractor 66.

[0027] The summed upstream data signals from adder 64 are transmitted on coaxial cable 20 to video source 12. The simultaneous transmission of active video signals and downstream data signals by video source 12 and transmission of upstream data signals by adder 64 results in both sets of signals being simultaneously present in coaxial cable 20 and at input/output 54. Thus, as at the outputs of VDA 14, a single transmission line 20 is used to transmit both downstream-directed signals and upstream-directed signals at the input of VDA 14. Subtractor 66 subtracts out the upstream data signals from the signals received at input/output 54, thereby leaving only the active video signals and downstream data signals to be transmitted to adders 56a, 56b, as mentioned above. Subtracting out the upstream data signals in subtractor 66 may be necessary in order to prevent collision of two sets of corresponding upstream data signals at the third inputs 52a, 52b of receiver-specific sections 36a, 36b.

[0028] One specific embodiment of VDA 14 is shown in Figures 2A-2C. One embodiment of common section 38 is depicted in Figure 2A. VDA 14 may include an input port 30 in the form of a coaxial cable connector. Adders 62, 64 may be in the form of a model LMH6644 amplifier produced by National Semiconductor Corporation and its associated connected circuitry, including discrete components such as various resistors and capacitors. Subtractor 66 may be in the form of another LMH6644 amplifier and its associated circuitry. The third amplifier shown in Figure 2A, receiving the output of subtractor 66, is arranged as an inverter performing a video clamp function, and has no corresponding function block in Figure 1.

[0029] One embodiment of first receiver-specific section 36a is depicted in Figure 2B. VDA 14 may include an output port 32a in the form of a second coaxial cable connector. Adder 56a and amplifiers 24a, 58a may be embodied in a fourth LMH6644 amplifier and its associated

circuitry. Subtractor 60a may be in the form of a fifth LMH6644 amplifier and its associated circuitry.

[0030] Finally, one embodiment of second receiver-specific section 36b is depicted in Figure 2C. VDA 14 may include an output port 32b in the form of a third coaxial cable connector. Adder 56b and amplifiers 24b, 58b may be embodied in a sixth LMH6644 amplifier and its associated circuitry. Subtractor 60b may be in the form of a seventh LMH6644 amplifier and its associated circuitry.

[0031] In the embodiment described above, the video system includes only two video receivers. However, it can be readily appreciated by one of skill in the art that the present invention can be easily applied to a video system having any number of video receivers. A simplified block diagram of the general case of a video system 110 having n number of video receivers $118_1, 118_2, \dots, 118_n$ is shown in Figure 3. The driving amplifiers and the receiver-specific sections of the bypass circuitry may be replicated for each additional receiver. Thus, video system 110 includes amplifiers $124_1, 124_2, \dots, 124_n$, and bypass circuitry 134 includes receiver-specific sections $136_1, 136_2, \dots, 136_n$. The first outputs $146_1, 146_2, \dots, 146_n$ of all n number of receiver-specific sections may be connected to the second inputs $144_1, 144_2, \dots, 144_n$ of all other receiver-specific sections. Moreover, the first outputs $146_1, 146_2, \dots, 146_n$ of all n receiver-specific sections can be connected to inputs $148_1, 148_2, \dots, 148_n$ of a common section 138. Finally, the output 142 of common section 138 may be connected to first inputs $140_1, 140_2, \dots, 140_n$ of all of the receiver-specific sections. Thus, any number of video receivers 118 may be in bi-directional communication with a single video source 112 and with each other.

[0032] In the embodiments described above, upstream data signals are not sent to the input of the amplifier that corresponds to the video receiver from which the upstream data signal originates. However, it is to be understood that it is also possible, within the scope of the present invention, for upstream data signals to be sent to the inputs of all amplifiers, including the amplifier that corresponds to the video receiver from which the upstream data signal originates. In this case, the upstream data signal could be subtracted out of both the output of the corresponding driving amplifier and the output of the corresponding bypass amplifier.

[0033] While this invention has been described as having an exemplary design, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles.